



Providing Low Cost Access to Space

SUSTAIN Conference briefing  
February 2009

Report Documentation Page			Form Approved OMB No. 0704-0188		
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1. REPORT DATE <b>2009</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>XCOR AeroSpace Providing Low Cost Access to Space</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>XCOR Aerospace</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>14</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			



## Company Status (XCOR in 60 sec)

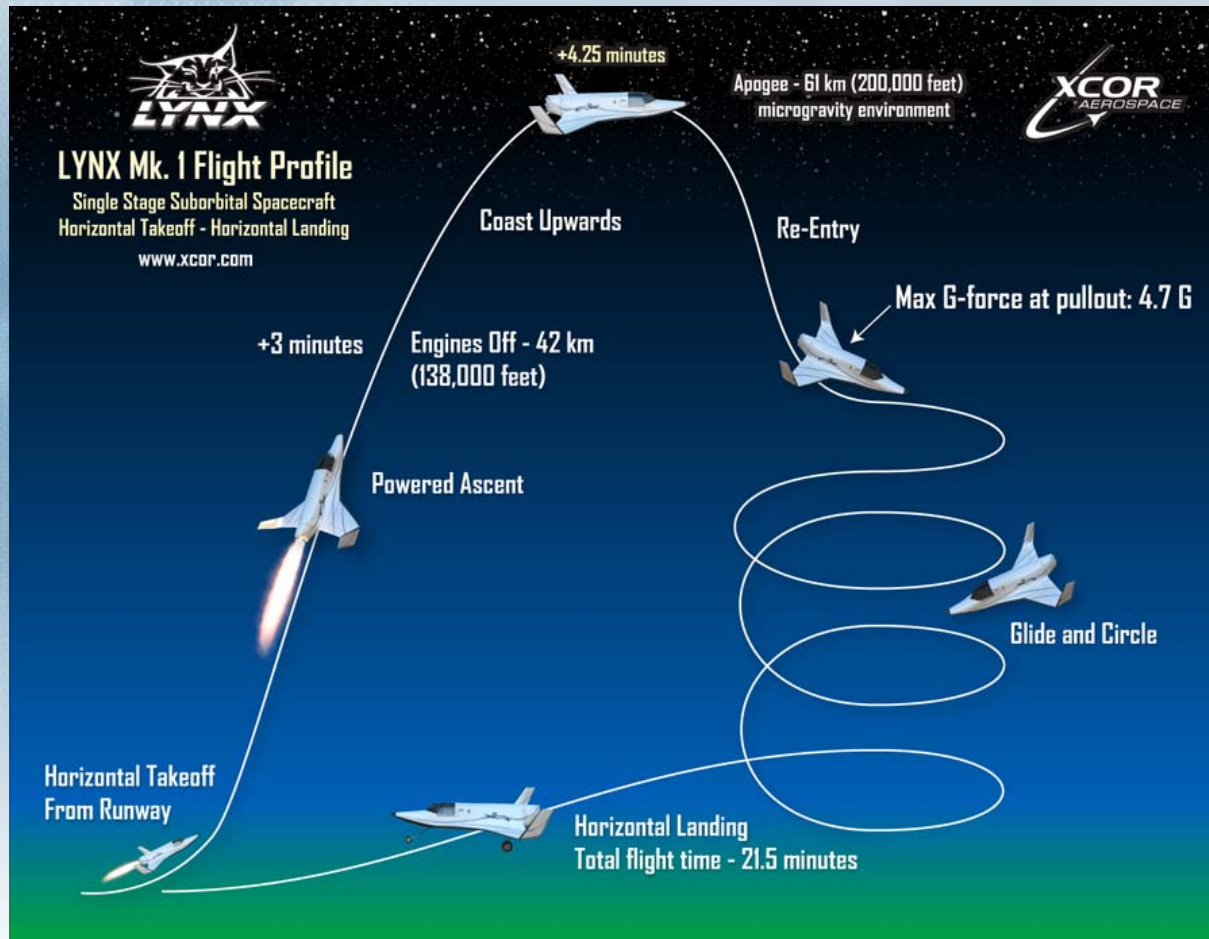
- Founded in 1999
- Located at Mojave Air & Spaceport
- Ten different rocket engine designs with over 3,500 firings
- Two generations of rocket powered vehicles built and flown
- Now designing Sub-Orbital Lynx & Lynx II space craft
- Funded by angel investors and revenues (\$2-3MM/yr)
- Customers : NASA, U.S. Air Force, SpaceX, Private Clients, ATK (NYSE: ATK) , Aurora Flight Systems, NRO, DARPA







# Lynx Flight Profile



Passenger & Science Missions



The View



Small Satellite Launch



# Operating Advantages Lynx and Lynx II

- Engine Technology
  - Low cost / low weight
  - High reliability
  - Highly re-usable
  - Environmentally friendly fuels
- Operational Advantages
  - Extremely low cost (\$95K/flight RETAIL)
  - Capable of 4 flights/day
  - Available < four hours notice
  - Multiple mission capability
    - passenger, scientific, recon, payload launch





## OTHER MISSIONS







# Other missions relevant to DoD

- **Surveillance Mission**

- **Pop-up Reconnaissance**

- Easy to transport anywhere in world and fly (6-8000 ft of runway needed)
    - Fly unpredictable times, multiple times per day, cheaply!

- **Small Satellite Launch**

- **Mark 2 with upper stage**

- Re-usable launcher, with small expendable upper stage – (priced ~\$500,000 / launch)
    - Lead time (standard payload interface) <3 days
    - 10kg payloads

- **Technology Demonstration**

- **Use of Lynx to augment other programs**

- Improve TRL of subsystems before inserting in to “bigsat” programs
    - Avoiding ONE failure or substantial program slip pays for the whole Lynx program many-fold



## UPDATE - Progress In Last 30 Days

- Further test firings of 2800 lbf LOX/Kerosene Lynx engine
- First successful “all-up” test of cryogenic multicylinder piston pump
- Engineering test article of Lynx cockpit being fabricated in shop now







## SUSTAIN & Similar Missions

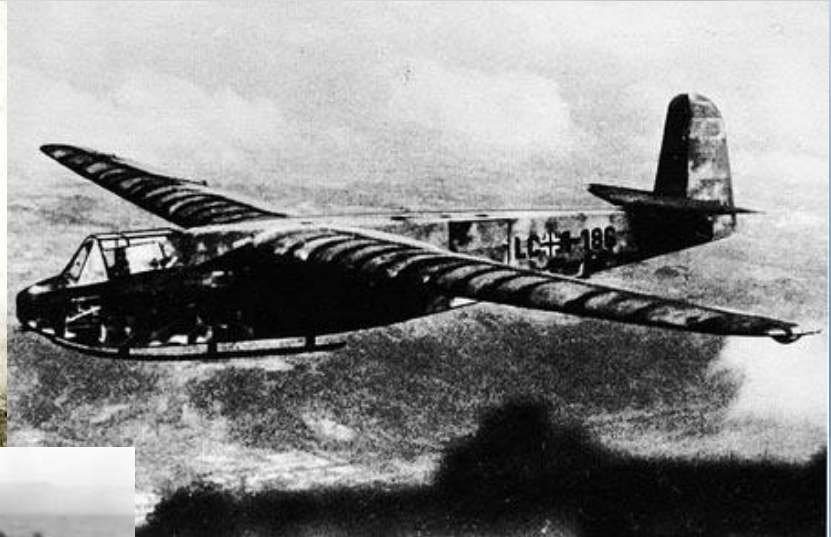
- XCOR may have a role to play in elements of such a system (launchers and related subsystems such as propulsion)
- In XCOR's view, neither we, or anyone else, will be building the One True Vehicle that fulfills this mission
  - If thought of as a **VEHICLE**, SUSTAIN is like trying to incorporate a MAU (troops, ship, assault craft, helicopters...) in one set of requirements
  - But viewed as a **SYSTEM**, no other military transport need from CONUS to target is done by single vehicle either!
- Therefore, a few thoughts on possible architecture



## How to get there?

- **Disaggregate Requirements**
  - **The less you require any one piece of the system to do, the easier that piece is to build. You can always explore “combined” functions later, AFTER you have the end-to-end system working**
- **Whenever you don't have the TRL or \$\$ to do the big thing, do a smaller thing – repeat until done**
  - **People are indivisible; squads are not**
    - Minimum unit in WW2 bombing was 8-20 aircraft to get the job done; but we never built the 32-80 engine B-117 “flying battlestar”
  - **Minimum “quantum” of insertion probably 2 people “buddy system”**
  - **Start shorter range (theater) and work up from there**

## Past Paradigms







## Notional architectures for full SUSTAIN

- NOT how it WILL or SHOULD be done – but to show some ways it CAN be done
- 3 Pieces: Launch, Ingress, Egress
- Launch – pick your favorite. Expend/reuse, VT/HT, VL/HL. But whatever it is, however far it throws it, it throws a payload (probably at least 2000lb), to the target



# Ingress

- **Space Paratroopers**

- “parachute” paradigm; troops released from delivery system
- TPS built in to suits or MOOSE-like solo system
- Aero deceleration high in atmosphere, GPS-guided chutes
- Formation flight automatically keeps troops on-target and in formation unlike WW2 drops

- **Capsule Troopers**

- Disposable capsule for 2+ people and equipment carries troops and equipment to target
- Doors permit rapid egress on landing
- As above, steerable chute/parafoil brings troops to target
- Capsules can carry many things besides troops
- Some capsules might include fixed weapons for securing LZ

## Extraction

- Once you have rapid transport, USE it to minimize combat load (keep sending resupply), and to deliver the egress means "on demand" instead of keeping it with you.
- "Yank me up, Scotty"
  - Launch a number of UAV's to target that exceeds troop count
  - UAV might be fast, stealthy, or both (ramjet?)
  - Uses skyhook-style system to pull troops out; once aboard, get out, 1500+ km away
  - Pressure suits act as protection from air loads until crew aboard
- "Retrieval boat"
  - Minimal craft, launched as a payload to target area
  - Lands vertically under steerable chute + retro rocket like Soyuz
  - Takes off vertically under rocket power to clear denied airspace, then airbreathing cruise to recovery zone







## The point

- If you break up the pieces, you DO NOT have to decide the one best way – each piece can proceed by itself and you can pick what you like.
- Perhaps, as with gliders and parachutes, or amphibious and helicopter operations, multiple modes will coexist, each suited for different purposes
- If you scale this down to small payload delivery (even 10kg??) you can start RIGHT NOW on demos for low \$\$
  - **Nothing sells like success, even at small scale....**